House Appropriations Subcommittee on Energy and Water Development

Overview Hearing: Gas Prices and Vehicle Technology

February 14, 2008

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Mr. Chairman and members of the Subcommittee, thank you for the opportunity to appear before you to discuss the current status of hybrid battery technology as it relates to transportation and the vehicle industry.

In the last 25 months there has been a dramatic development in automotive and vehicle technology in North America. This development relates to the rapid adoption of hybrid and particularly Plug-in Hybrid Electric Vehicle (PHEV) technology programs by the nation's automakers. This is occurring for a variety of reasons, including relatively sustained government funding of automotive technology development programs, tough clean-air standards that are challenging to wider deployment of diesels, the successful creation of improved battery chemistries, the creative and innovative spirit of small American businesses, and perhaps foremost, the rapid increase in U.S. fuel prices and growing dependence on imported oil.

While the reasons for the sudden interest in plug-in hybrids are many, it is clear that we are in the midst of a revolution in automotive technology similar to the expansion of the auto industry during its infancy at the start of the last century.

The first modern hybrid vehicles were developed through U.S. Government research programs in the early 1990's. There was no commercialization because of low fuel prices, lack of battery technology, and immature power electronics development, all of which contributed to make the vehicles expensive and inefficient. In the late 1990's, Toyota produced the first successful hybrid using new nickel metal hydride batteries (NiMH). Toyota currently manufactures its hybrid vehicles in Japan and exports those vehicles to North America.

The hybrid-vehicle market is estimated at 504,000 vehicles in 2007 – this is less than 3% of the total vehicle market. This share is projected to grow at an average rate of 30% over the next four years and could reach 2 million units by 2015. This growth is dramatic in automotive terms and the competition between manufacturers is intense. Toyota produces more than 80% of the hybrids sold in the U.S., and this situation is not likely to change soon. Ford and GM have both produced viable hybrids, but the production of these is slowly ramping up because of limitations

on materials and high costs. The GM 2-mode hybrid is arguably the world's most advanced, but the Toyota system is more mature and available on more models. Ford has a hybrid system similar to Toyota's system, but they have publicly stated that they were severely hampered by a lack of access to advanced battery technology in high volumes, and to high battery costs.

The potential for hybrid technology to reduce fuel usage is high. Hybrids can improve fuel economy up to 25%, and testing to this point indicates that plug-in hybrids can further improve fuel economy substantially. The fuel economy of plug-in hybrid prototypes as measured at Argonne has exceeded 100 mpg - without optimization. This number sounds a bit sensational, and I am hesitant to use fuel economy when talking about plug-in hybrids, but suffice it to say that the plug-in hybrids have great potential.

In all cases, whether hybrids or plug-in hybrids, the batteries are the key enabling technology, and lithium ion battery chemistries are the leading candidate for solving automotive battery issues. The U.S. is dominant in the development of battery materials and chemistries, although many of the fundamental breakthroughs in battery technology have been subsequently licensed overseas. The DOE battery research programs have spawned small businesses and pushed applied development of promising battery chemistries to a high level. National laboratory programs for battery development and testing continue to be successful, but the U.S. is behind the rest of the world in the adoption of battery manufacturing capability. Many small American battery companies plan to build their factories in China. NiMH automotive technology was initially developed in the U.S., but has been commercialized by Panasonic and Sanyo, and is mainly manufactured in Japan and Korea, and is available on most Toyota hybrids.

Several countries have an advanced battery research capability:

Japan recognizes advanced battery technology as the key driving force behind competitiveness and hence views it as an issue of "national survival." The Japanese Government is very supportive in funding research programs and has committed to a 20-year research program.

China is the planned location for many new manufacturing facilities. Their battery manufacturing methods are often labor intensive, and at this time not well refined; however, China will quickly develop capability and will maintain lower production costs. Naturally the American companies are attracted to this location.

Korea has low-cost aggressive companies, but is more a follower than a leader on chemistry and materials.

Germany has announced "The German Battery Alliance" with intent to develop a homegrown battery manufacturing capability. The project's objective is to substantially increase the energy and performance density of lithium-ion batteries and to assist Germany's automotive industry. Around €420M (about $600 million) will be invested in the initiative by the Federal Ministry for Education and Research.

The U.S. is the leader in battery materials and chemistry development, and also leads battery start-up activities and innovation. The major problem with the U.S. is that it lacks manufacturing or prototyping capability. Battery manufacturing know-how and capability are developed over time and require huge capital investments. Toyota has invested substantial funding in developing the capability to develop and produce batteries. Estimates of costs vary, but studies indicate that Toyota pays one-third less for their batteries than do the American-owned companies.

Asian-based battery makers have marked advantages based on the large investments they have made in manufacturing. No matter how good the chemistry, one needs manufacturing skill to produce commercial batteries. Lithium-ion batteries are complicated devices that are prone to overheat, leak, and fail, no matter what chemistries they use. Superior design can minimize the chance of these faults occurring, but if you don't have advanced manufacturing methods you cannot make high-quality, durable, and safe commercial batteries.

Beyond manufacturing, the two biggest concerns with the lithium ion technology are safety and cost. While lithium ion battery safety is a concern, the problems are solvable, meaning that the limiting factor to PHEV introduction will likely be cost. Estimates of battery cost range from roughly $3,000 to $12,000 for the expected 40 mile plug-in battery (PHEV-40). At these levels the major hurdle to introducing plug-in hybrid technology is that the projected fuel dollar savings are considerably lower than the cost of the battery. In other words, there is no payback.

To get a payback, we either need to lower battery costs, or we need larger differences between gasoline and electricity costs. Battery costs can be lowered with increased funding for research and development of advanced materials, tax policies and R&D tax credits, or incentives. From the automakers point of view, with batteries not ready for commercial introduction, the business risk of introducing a plug-in hybrid is tremendous. Especially because automotive battery warrantees are for the “life-of-the-car”.

Specific, focused North American battery manufacturing incentives could spur further progress. A SEMATECH-like program focused on developing a manufacturing capability might help jump-start a homegrown battery industry in North America.

Government should continue support for research and development, provide market incentives for conventional hybrids, and consider added incentives for plug-in hybrids. Government R&D funding for advanced vehicles should better reflect the likelihood of success. A sustained effort to develop domestic battery manufacturing capability will be equally important. Ultimately, we have not accomplished much if we transfer a dependence on imported oil, for an addiction to foreign batteries.